Development of Brain-Computer Interfaces using Evolvable Hardware

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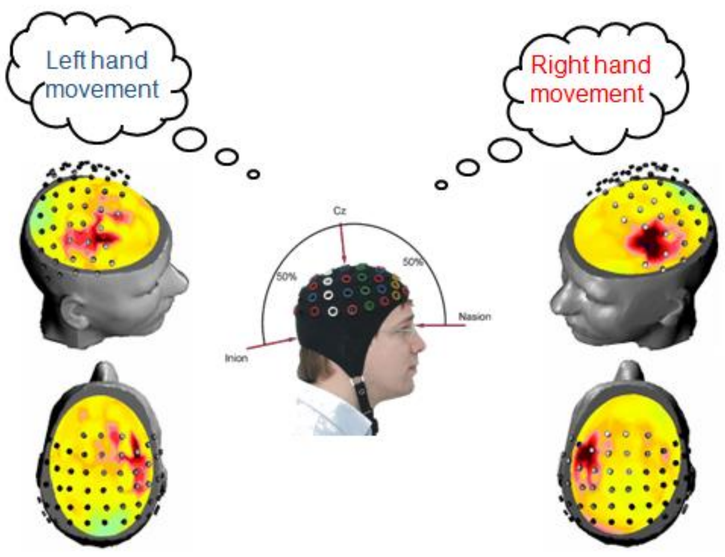
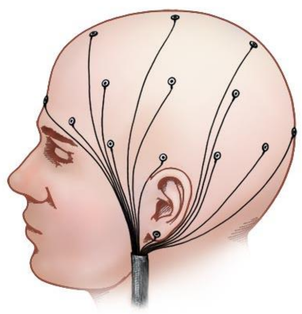
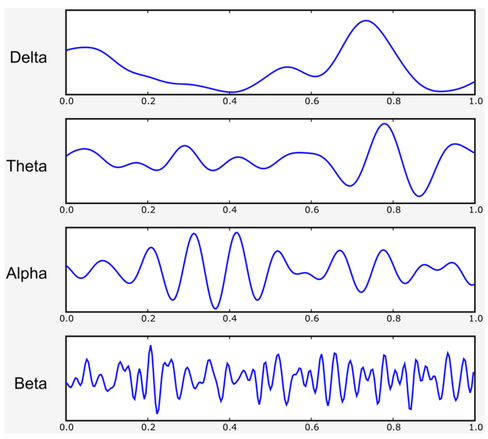
Summary. **Brain-Computer Interfaces are usually tackled from a medical point of view, correlating observed phenomena to physical facts known about the brain. Existing methods of classification lie in the application of deterministic algorithms and depend on certain degree of knowledge about the underlying phenomena so as to process data. In this demo, different architectures for an evolvable hardware classifier implemented on an FPGA are proposed, in line with the objective of generalizing evolutionary algorithms regardless of the application.**



Data acquisition and segmentation → **Feature extraction** → **Classification (induction)**

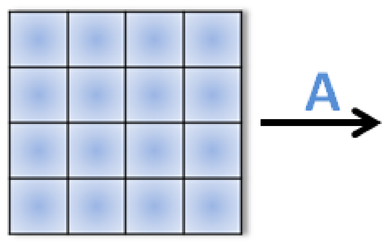




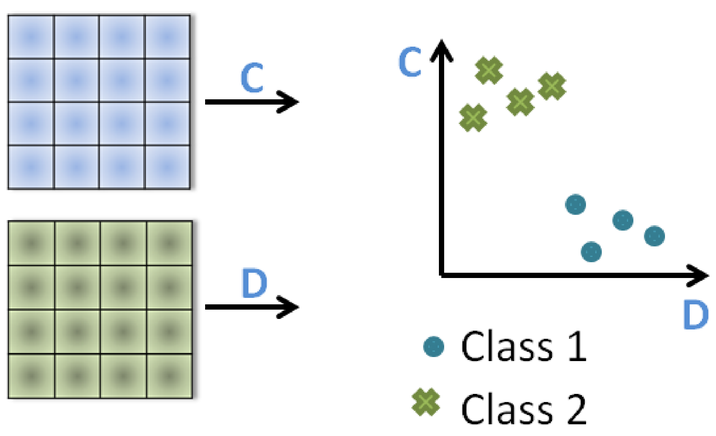
WRAPPER METHODS

- Feature selection uses induction algorithm

SIMPLE

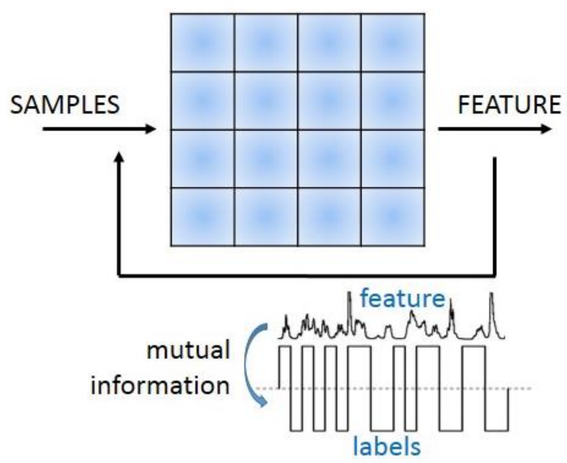


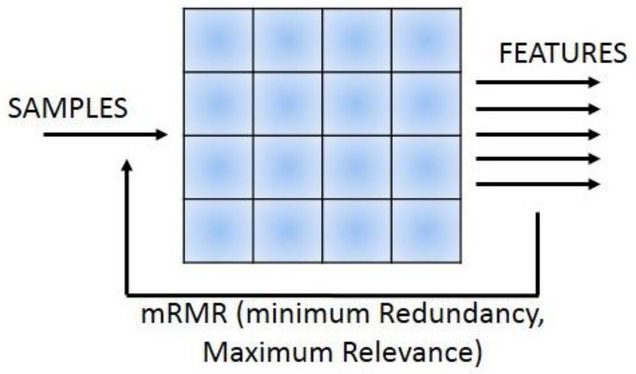
2D



FILTER METHODS

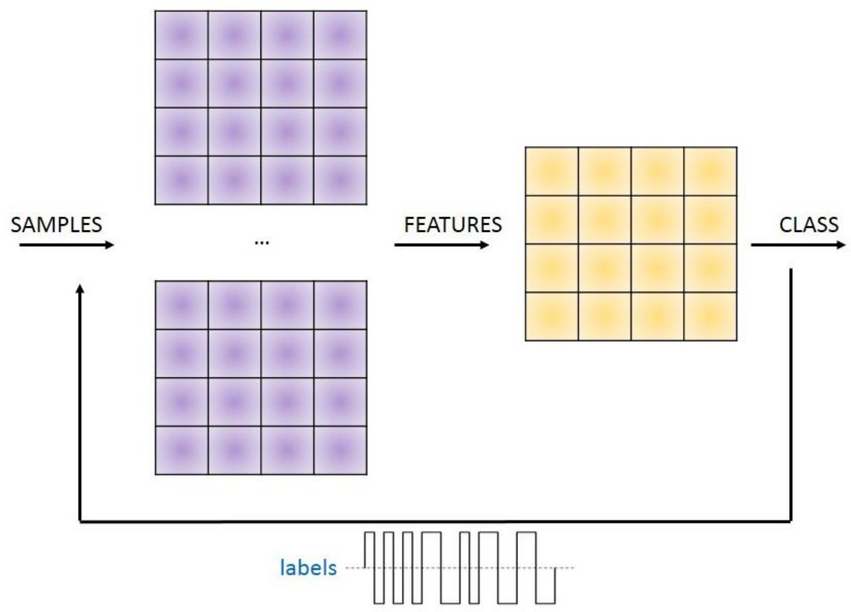
- Feature selection precedes induction





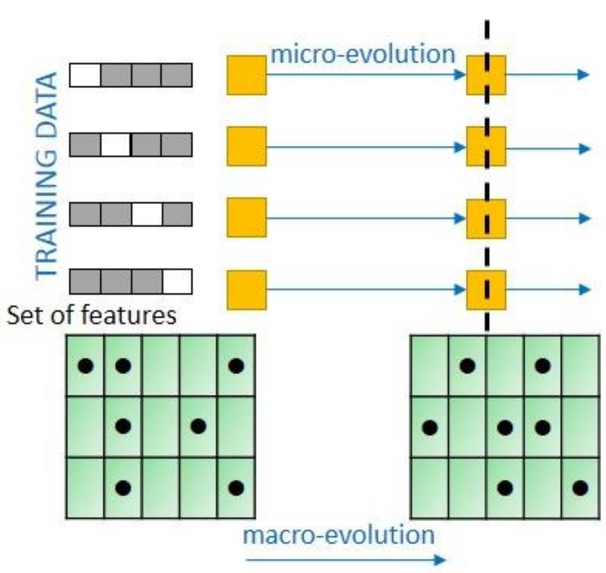
EMBEDDED METHODS

- Feature selection and induction are indivisible

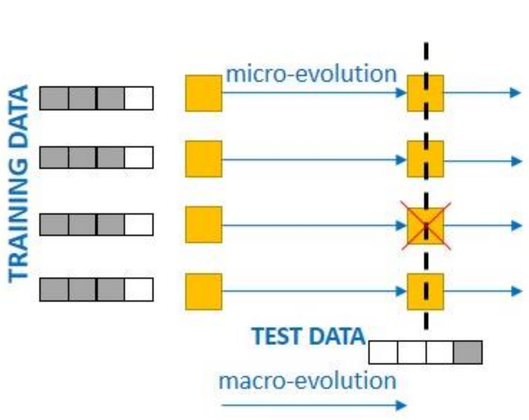


FIGHTING OVERFITTING

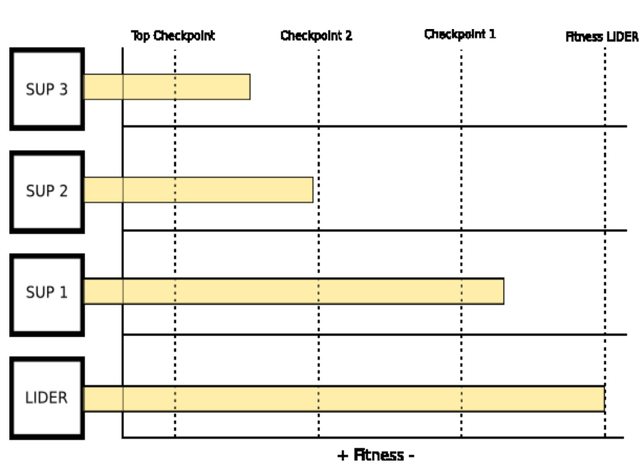
"Macro-micro evolution"



- Imitation of k-fold cross validation
- Cross validation error used as fitness at macro-generations

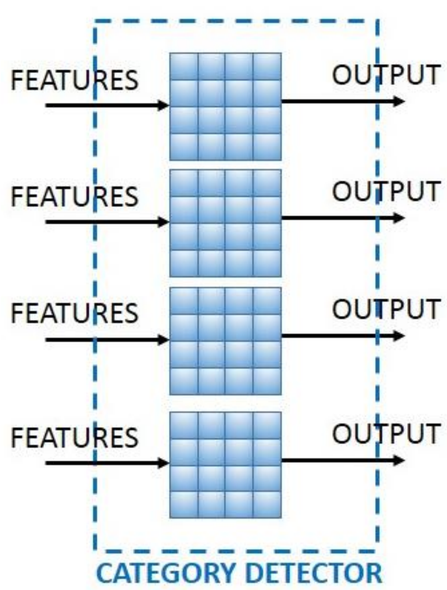


- Training is performed upon part of the data, fitness on predicting the other part serves at macro-generations
- The best replaces the worst at macro-generations



- "Tribal-supervised" evolution
- Supervisor evolutions are obliged to stay within some fitness limits
- Supervisor evolutions improving the one below replace it

Several detection rules



- Category detectors specialized in each class
- The highest sum of outputs "wins"